OPERATIONAL TOPIC

Radiological Control Organizations need to be able to evaluate evidence when skin and clothing contamination incidents occur to find the cause and take actions to prevent recurrence

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Possible Causes of Skin and Clothing Contamination Incidents and Actions Needed to Prevent their Recurrence

Abstract: Sometimes, in spite of everything we do, workers get radioactively contaminated on their skin or clothing. The radiological Control Organization normally has the job of finding out what happened and what actions are needed so that it never happens again. Often, the cause isn't obvious, and we do our best to decide what probably happened. The following information documents a common sense approach to determining the probable cause and what actions are needed to reduce the number of occurrences.

At a DOE Site, such as the Hanford Nuclear Reservation, workers are heavily involved with efforts to clean up old processing facilities, put them in safe condition, and perform decontamination and decommissioning work. These facilities contain a myriad of radioactive isotopes that are located inside the plant systems, underground tanks and the soil. In addition to being radioactive, they are also toxic and hazardous materials. To accomplish this mission, workers are trained to control the spread of radioactive contamination.

Control of radioactive contamination can normally be achieved by using proper radiological work practices and mixing and matching engineered controls to confine the spread of contamination. By controlling contamination, the potential for internal exposure and personnel contamination can be decreased. In spite of efforts to have no skin or clothing contamination incidents, they sometimes occur. When this happens, trained personnel need to evaluate what happened and determine what must be done to prevent recurrence. When asked to evaluate an incident where the probable cause isn't intuitively obvious, consider the following:

PROBABLE CAUSES

Evaluate the type of work**. Personnel are often contaminated during strenuous work involving flexing, lifting, working on hands/knees, or other physical movements. If the worker sweats profusely, the protective clothing becomes soaking wet and contamination can easily penetrate the layers of protective clothing. Consider increasing the ventilation and regulating the temperature if possible. Look at finding better tools or change the procedure so the job can be performed with less exertion.

Study the working conditions. Past occurrences reveal most incidents occurred in hot, humid, or damp conditions. In addition, the work area may be cramped or a confined space and the workers were forced to work for long periods in these conditions. Unnecessary materials, tools and equipment could be removed or repositioned to give workers more room. If high levels of loose contamination exist in the work area, it should be decontaminated. As the work progresses, it may be necessary to stop work and decontaminate often to keep contamination levels low. The lower the contamination levels, the less chance that contamination will be spread in the work area and on to personnel.

The protective clothing requirements should be based on the expected contamination levels, form, and stability of the contamination. Cloth or water-resistant clothing often fails to protect workers during demanding work conditions or activities. Multiple sets of protective clothes or the wearing of impermeable plastic clothing increases the potential that the worker will have heat stress. It may be necessary to decontaminate the work area, apply strippable decontamination paint, or cover the contamination with plastic or paper to reduce the risk the worker will become contaminated and get the protective clothing requirements reduced. Evaluate changes that would improve the working conditions and replace workers more often so they remain fresh.

If a person is found to be contaminated after wearing protective clothing, try and recover his/her protective clothing so that it can be surveyed and inspected for holes, rips and tears. Consider removing a portion of the contaminated protective clothing for isotopic analysis.

Determine the area of the worker's body or clothing that is becoming contaminated. Efforts may then be concentrated on those specific locations to determine the cause and take the appropriate corrective action. Normally the legs and arms are contaminated more than other areas. On the legs, the knees are contaminated more than other areas. This appears to be caused by prolonged contact with contaminated surfaces, physical work that causes perspiration, and high stress placed on the protective clothing. On the arms, the forearms seem to get contaminated more than other areas. Workers use their forearms to enter small spaces, maneuver tools, lean against surfaces, or otherwise come in contact with contamination. Corrective actions have included rubber-coated or plastic arm sleeves, aprons, and other protective devices. Protective clothing can be reinforced at the knee, elbow, and other locations so it will be less likely to puncture.

Determine how the contamination is spread. Often, the contaminated area will correspond to sections of the protective clothing that are perspiration soaked, had prolonged contact with contamination, or there was a rip or tear in the clothing. Frequently, perspiration soaked clothing is completely intact, with no holes or tears.

Improper laundering of protective clothing may leave residual contamination, which can transfer, to the user. Surveys of returned laundry should be increased if it is suspected to be a causal factor. Surveys should be performed prior to removal of laundry bags from the vehicle and results should reveal the laundry meets the levels listed in the laundry contract. Laundry above limits should be returned to the vendor and documented on a Radiological Problem Report or equivalent. There is a tendency to blame contaminated laundry when there is no other obvious cause of skin or clothing contamination. If the clothing is handled correctly and laundered properly, it is rarely the cause. Consider switching to disposable clothing to see if the skin and clothing contamination incidents continue.

A prime cause of skin contamination occurs during the removal of protective clothing. Hurrying or improper removal, especially at lunchtime and near the end of the shift, may contribute to this problem. If this is found to be occurring, the workers should be reminded to undress the same way they were trained. Emphasize the importance of following each step of the undressing procedure verbatim, completing each step in a slow, deliberate manner, before going to the next step. Supervisory personnel should be encouraged to monitor the undressing of their workers occasionally to identify problem areas. Workers who continue to have a problem undressing properly need to be retrained. It may be necessary to videotape workers while they undress in order to refine the techniques and spot possible practices that are causing the skin or clothing contamination. If the sequence of removing protective clothing is different than what the workers were required to demonstrate during their initial radiological control training it may be desirable to have each worker demonstrate they can remove their protective clothing satisfactorily in a mockup before the job starts.

Other actions that have helped determine the cause:

Assess the work practices used by the workers to determine if they are proficient and use good contamination control techniques. If necessary, training radiological workers in contamination control work practices can be accomplished by having the workers attend training classes, reading periodic training bulletins, and discussions at safety meetings. Consideration should be given to mockup training and/or special skills training for complex radioactive jobs. The mockup training should closely simulate actual conditions in the work area and personnel should wear the same protective clothing. Assessing the work practices used by the workers and RCTs should give a picture of what happens in the work area and the work steps where workers are likely to become contaminated.

Managers should review contamination control policy guidance with workers to assure the workers understand what's expected. Managers may need to reemphasize worker accountability for radiological and work control requirements and their responsibility to not get contaminated. This will assure that workers understand management's commitment to perform the work safely without contaminating the environment or themselves.
Managers need to attend prejob briefings on a frequent basis and enter the actual work areas while jobs are in progress to assess the radiological work practices. Prejob briefings provide an opportunity to assess the readiness of personnel to perform radiological work. Managers should evaluate the prejob briefings for jobs that have complex radiological controls to determine if workers and RCTs understand the requirements and what is expected of them. The Person-in-Charge should ensure each key step of the job is discussed and the steps that could result in a spread of contamination, overexposure, or create unnecessary radioactive waste are covered in detail. Managers should ensure the undressing requirements are the same as was taught in the worker’s training classes.

Consider the use of different "engineered controls" to reduce the risk. The use of containments, glove bags and HEPA filtered ventilation are proven ways to accomplish complex radiological work in a safe manner. Other engineered controls include the use of remote handling equipment, robotics, fixatives, expandable foam, and specialized decontamination methods to reduce contamination levels. Hoses from HEPA filtered vacuum cleaners can be attached to "shrouded" tools to capture contamination and keep it from spreading. Communication systems and closed circuit television can be used to communicate with the workers and reduce the number of workers who have to enter contamination areas.

If high airborne radioactivity exists in the work area, determine where the radioactive particles are originating. It may be necessary to cover the contamination, decontaminate the source, or use an aerosol fogging device to spray a mist into the air and capture airborne particles and/or keep them from becoming airborne.

Checklists and polices used to review work procedures and prepare Radiological Work Permits should be evaluated to ensure the guidance given to planning personnel, who must establish the radiological controls, are adequate.

If workers are working without respirators and their faces are becoming contaminated, consider changing the protective clothing requirements to have them wear clear plastic face shields. This should keep them from touching their face.

"Sticky" pads can be laid in the undressing areas of controlled areas. This can reduce a number of "false alarms" caused by workers with naturally occurring radioactive isotopes on their shoes.

If the work area contains "Fixed Contamination Areas" which have been painted over, the cause of shoe contamination may be due to deterioration of the outer layers of paint covering the fixed contamination. Normally, yellow paint is applied directly to the area and is followed by one or more layers of non-yellow paint.

Conduct critiques for events and "near misses". Find the "root cause" and identify what corrective actions are necessary. Assign actions and due dates wherever possible.

If the source of the contamination is still a mystery, determine what, if anything has changed in the work area. Is the ventilation operating at full capacity? Have other systems been shutdown that would cause contamination to migrate? Are there other radioactive materials stored in the work area? Are the protective coatings covering fixed Contamination Areas still intact?

Conclusion

These recommendations should provide clues that will help the evaluator determine probable cause(s) as to why workers are getting contaminated. Once the probable causes are known, actions to reduce the number of occurrences should be obvious.

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*** Radioactive Contamination Incidents Involving Protective Clothing, by R. Reichelt, M. Clay, and A. J. Eichorst of Los Alamos National Laboratory, Los Alamos, NM 87545*

Attachment A

Selection of Protective Clothing

Protective clothing is the prime method used to ensure contamination does not get on the worker's skin or clothing. There is a wide selection of protective clothing available that is either disposable or can be laundered. In addition, the clothing may be breathable or impermeable.

DOE does not have standards for the minimum performance expectations of protective clothing. Each company purchases clothing to fit their application. Some of the considerations are:

a. How effective is the clothing at protecting the worker?
b. How durable is the clothing?
c. Is it easy to don and doff?
d. How comfortable is it? (Consider heat stress, weight, allergic reactions,)
e. Is it easy to decontaminate or dispose of?
f. Does it resist tears or wear?
g. Does it meet flammability specifications?
h. What effect does solvents and corrosives have on the fabric and seams?
i. Does the material retain static electricity?
j. What is the cost of disposing of the clothing as low-level radioactive waste? What does it cost to launder it?

At Hanford we have found that on some jobs, higher technology clothing that breathes may be a better value than wearing multiple sets of protective clothing. The clothing breathes, but the worker doesn't get wet if the clothing is splashed with water.

There is information on a DOE Website on different types of protective clothing. The website is: http://em-50.em.doe.gov Click on "Publications" and then click on "Technology Reports". The reports are listed alphabetically.

Report No.	Title	Remarks
DOE/EM-0353	Frham-Tex Cool Suit	High-Tech Clothing
DOE/EM-0354	NuFab Anti-Contamination Suit	
DOE/EM-0377	Sealed Seam Sack Suits	Compares 6 kinds of Disposable Clothing to Launderable Clothing